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SOME PROBLEMS OF MINERAL GENESIS IN SOUTH AFRICA[1]

CHARLES PALACHE, *Harvard University*

On the day upon which the Mineralogical Society of America convenes for its second annual meeting, the writer sails from England for Cape Town to undertake, as a member of the Shaler Memorial Expedition to South Africa, a tour of several months duration among the more interesting geological and mineralogical regions of that country. He trusts that it will appear fitting to the members of the Society that under these circumstances his address to you should deal with some of the problems of mineral occurrence and genesis of which he has read in the South African literature and some of which he may hope to study in the field. Travelling through so vast a country for a limited time, a visitor can scarcely hope to add much to the detailed observations of the resident students of these problems. But he can at least bring to bear upon them a new point of view and may reasonably expect to clarify his own interpretation of described phenomena after visiting the localities, even though he may not add largely to the store of observed facts.

THE DIAMOND

The unique opportunities for the study of the origin of the diamond offered by the deep mines of the Cape Colony have been so well availed of by the geologists of South Africa that we may regard the problem as solved, at least for that region. Wagner's book sums up so admirably all the available evidence that there need be no hesitation in accepting as proved the igneous origin of the diamond as an accessory constituent of kimberlite. Some related questions still remain, however, which seem to invite further consideration although they are on the whole largely geological and to a high degree speculative in their nature.

[1] Presidential Address, presented at the second annual meeting of the Mineralogical Society of America, Amherst, Mass., December 29, 1921.

First. What is the mechanism by which the pipes now filled with kimberlite were opened? It has been adequately shown that groups of pipes are more or less aligned along fissures in some cases; and that individual pipes change their form in depth and become more or less fissure-like in cross section. Yet some pipes are quite isolated and preserve the verticality of their walls to great depths. The mechanical process by which these vertical holes have been produced, penetrating rocks of utmost variation of texture and resistance for thousands of feet without essential change of form or size has not, I think, been elucidated.

May it not be possible to learn from a critical study of the actual walls and minute features of these reexcavated volcanic vents more of the nature of the agents which were there active? Was the hole punched out by an explosion which actually drove before it a solid column of rock? Was it rather an attack by solvent gases acting under great pressure and removing the obstructing column of rock by chemical attack combined with spalling off of the superheated surfaces exposed to their action? Or was the removal of the rock due to a stoping action effected by projectiles in the solid state which ground or bored their way upward? Anything that might be learned as to these processes from the diamond pipes, the only volcanic conduits which have been or are likely to be laid open by mining operations and thus made subject to minute examination, will have an application as wide as the whole field of volcanology.

Second. What causes produce the wide variation in amount and characters of the diamonds in different pipes? While the rock contents of the pipes as a whole present a remarkable similarity over wide areas, the accessory constituents, especially the diamond, vary widely from one pipe to another. The expert is said to be able to tell with some degree of accuracy from which of the known pipes a given parcel of stones or even an individual diamond was taken. He judges by crystal habit, prevailing color, average size and a number of other characters. On the basis of such a judgment it is confidently asserted that the diamonds of the coast placers of the former German Southwest Africa could not have been derived from any known pipe. The amount of diamond necessary in the blue ground for economic working varies in the active mines from about one part in ten millions to one in forty millions of rock. The amount is thus at most

minute. The explanation of the apparent total absence of diamonds in many pipes and of these local variations in character of the stones is probably to be found in the delicate equilibrium existing between the molten magma and the carbon in solution. Goldschmidt and Fersmann showed in their study of diamond crystals that the forms of growth and of solution were markedly different; that few crystals had escaped solution etching; and that a crystal might even have been growing on certain faces in the same magmatic solution that was dissolving material from other faces. The control of the saturated condition of the solution is thus sensitive but its nature is quite unknown. It may well be temperature or pressure; or the presence of other dissolved substances. The latter would be most likely to cause variation of color or other physical characters of the diamond crystals. And for the absence of diamond from so many pipes at least two explanations may be suggested. Carbon may never have been present in the magma of a particular locality. It seems more likely that it is always present but may be held in solution by peculiar chemical or physical conditions through the cooling period in which diamond can form and thus remains in solid solution in the rock. The ultimate source of the carbon is of course problematic. The sporadic distribution of diamond in the pipes might be explained by postulating local digestion in the magma of older, carbon-containing rocks. But it seems more probable that it is derived from the dissociation of carbon oxide gases in the magma, the carbon separating under favorable conditions as diamond.

Third. Some relations of the kimberlite magma. The wide distribution of kimberlite-filled pipes demands consideration. First found near what is now Kimberley and in the neighboring Orange Free State, later discoveries extended the area of their occurrence first to Pretoria in the Transvaal and then by a vast expansion north and west to southern portion of the Belgian Congo and to (German) Southwest Africa. Pipes of analogous character, except for the absence of diamonds, were also found not only in the vicinity of those developed as diamond mines but also over an extensive area to the south in Cape Colony. The pipes are thus distributed very irregularly over an area of roughly a million and a half square miles. Wherever found they are characterized by a general similarity of the rock filling. It is a basic magma rich in magnesia and lime, rather high in titanium

and low in alkalies, yielding such minerals as olivine, diallage, mellilite and perofskite, generally largely altered to serpentine. The age of the pipes is not definitely known but they seem always to be later than the Karroo (Permian) and at least as late as Cretaceous. Are we not justified in believing that these hundreds of volcanic vents are related to a common and coextensive magma horizon? The speculation is particularly interesting if viewed in connection with two other widely distributed groups of igneous rocks in neighboring areas. The Karroo dolerites recently described most graphically by Du Toit are of basaltic type. They were intruded in a complex of sills and dikes or poured out as lava flows over an area of at least two hundred thousand square miles lying on the whole to the southeast of the diamondiferous pipes but overlapping them in part. On the other hand, to the north east in the region of the Rift Valley are the lava flows and great volcanoes of Central Africa dating from Tertiary times to the present. Covering a region comparable in extent to those already considered they exhibit a third type of magma, highly alkaline and low in magnesia and lime. Differing thus in age, in character of materials and in mode of extrusion, these groups of rocks seem to offer an exceptional problem in regional differentiation of igneous magma on a gigantic scale.

GOLD

An outstanding feature of the widespread gold deposits of South Africa is their almost universal association with quartzites or quartzitic conglomerates, the "banket" of the African miner. This association is found in rocks of several geological periods and over a vast area extending northwards from the Rand at least as far as the Belgian Congo on the Rhodesian boundary. This mode of occurrence is the more noteworthy in that it is not characteristic of any other important gold region and a vigorous controversy has arisen as to the mode of emplacement of the gold in the deposits. The evidence collected by a host of skillful observers and marshalled in behalf of one or another of two principal theories is conflicting.

The placer theory, whether the conglomerates be regarded as marine or as delta or flood-plain deposits, has the obvious advantage of simplicity. But when an effort is made to discover among recent deposits or on the shores of the present seas placers

which at all resemble the gold reefs of South Africa, the result is conspicuously unfavorable. The kind of sorting action leading to coarse pebble accumulation on beaches is not likely to produce at the same time and place concentration of heavy minerals like gold and its associates. Delta or flood-plain deposits are characteristically discontinuous; it is difficult to conceive of the formation under those conditions of the mile-wide stretches of "banket" with its constancy of thickness, pebble character and gold content. The abundant pyrite of the cement and the absence of gold in the pebbles are alike difficult to explain on any placer hypothesis. If it is argued that exceptional conditions of sedimentation may be assumed for particular deposits, it is to be remembered that essentially identical deposits have here been formed in several geological epochs and in widely separated regions, so that the inherent probability of exceptional conditions becomes vastly diminished.

The alternative theory regards the gold as introduced into the sedimentary beds posterior to their formation by solutions of deep-seated origin. According to this theory the conglomerates are the seat of gold deposition because, as the most permeable rocks, they offered the easiest passage to invading gold-bearing solutions.

The writer's judgment leans strongly towards the second hypothesis, possibly in part because of his having spent two seasons in intensive study, with others, of the copper-bearing conglomerates of Lake Superior. There a conglomerate horizon singularly comparable to those of the Rand has become the seat of deposition of metallic copper which replaces the cement of the pebbles and in part even the pebbles themselves. In this case of course there is no possibility of explaining the presence of the copper by contemporaneous deposition or indeed by any other agent than copper-bearing solutions. The degree to which copper has been uniformly introduced into large areas of conglomerate without material alteration of the pebbles as a whole; and the remarkable selective action through which one bed has been saturated with copper and another, near at hand and apparently quite as favorable to the permeation of solutions, has been entirely unaffected; these and other features offer striking analogies to conditions described in the Rand and other African gold deposits.

Certain other considerations, some of which may be mentioned, lead in the same direction. Developments in the Rand mines have revealed numerous large diabase intrusions which might well have functioned as sources of ore-bearing solutions.

There are good reasons for believing that in the neighborhood of the gold deposits deeper seated intrusions exist, as yet unrevealed, which as proved in the case of the Bushveld laccolite, might profoundly modify overlying rocks both by contact metamorphism and by the action of post-magmatic solutions. The presence in some of the gold districts of typical gold-quartz veins offers sure proof that gold-bearing solutions were active. Time does not suffice to even summarize various other lines of evidence bearing on this problem, certainly one of the most interesting offered by the South African field.

COPPER

Until recently the copper deposits of South Africa have been of minor importance. With the exploration of the Katanga region in southern Belgian Congo, however, a copper-bearing formation apparently of the first importance has been revealed. The district in which the copper ores occur is very extensive but their nature is as yet imperfectly understood. They consist of beds of sandstone or of silicified dolomite, of the same age, probably, as the gold-bearing Rand formation, in which at the surface copper carbonates and silicates replace the original rock minerals. There are indications that as depth is gained the rich oxidized ores are giving place to sulfides of copper or to cupriferous pyrite. The copper ores contain a considerable percentage of cobalt as well as some gold and platinum; and one deposit at least is rather a gold than a copper ore. All descriptions seem to indicate that the Katanga ores are replacement deposits; the analogy with the better-known gold deposits is striking and it would seem that this field would perhaps be a critical one for the correct solution of the problem of the nature of the gold banket.

NICKEL and PLATINUM

At Insizwa in southeastern Cape Colony, in a thick sill of diabase belonging to the Karroo igneous series, a basal differentiate of nickel-bearing pyrrhotite has been discovered which seems to reproduce many of the features of the Sudbury copper-nickel

deposit. In view of the conflicting testimony as to the true nature of the Sudbury ores it seems probable that the smaller and presumably less complex African deposit may give valuable evidence bearing on the formation of magmatic sulfide deposits.

Very recently an occurrence of platinum has been discovered in the same general region. The platinum is reported to occur in the free state in diabase, from weathered portions of which as well as in derived gravels the metal may be obtained by panning. It is hoped that this novel and interesting locality will prove accessible to our party.

CHROMITE

The extensive deposits of chromite at Selukwe in Rhodesia have for some years practically supplied the world with this mineral. As described by Zealley the chromite occurs in lenses and disseminated throughout the enclosing rocks which are largely talc-schist, talc-carbonate schist and silicified serpentine with a very subordinate amount of serpentine. The peridotite from which these rocks have been derived is intruded by an extensive mass of granite which extends in ultra-acid dikes into the chromite deposits. The association of chromite with talc on so large a scale is the novel feature of these deposits. The chromite is believed to be an original magmatic crystallization from the peridotite. It would be interesting to consider the question whether the presence of the intrusive granite may be responsible for the abnormal metamorphism of the peridotite.

CORUNDUM

Corundum has been found in deposits scattered over wide areas of the Northeastern Transvaal within the past few years. It occurs partly in well formed crystals up to 15 cm (six inches) or more in length, partly in granular masses, associated with white plagioclase feldspar. The corundum rock is described under the name of plumasite in a recent report of the Union Geological Survey by Hall. He finds that it occurs always as a contact layer about large xenoliths of an older ultrabasic rock series which have been engulfed in an intrusive granite. The corundum rock is regarded as a reaction product between the two materials. The field is large and many mines are being opened although the main production is from eluvial deposits. Hall's descriptions

reveal a wide variety of local developments and the further study of this region should largely advance our understanding of the puzzling paragenesis of corundum contact deposits.

ASBESTOS

Blue asbestos or crocidolite and its derivative, the ornamental stone termed Tiger's-eye, have long been associated in the popular mind with the diamond as the typical South African minerals. Recent discoveries in the Transvaal of asbestos of a different, but related type, have led to a thorough examination of all the South African asbestos deposits and the report on them by Hall contains much that excites the interest of the mineralogist. Crocidolite is well known to be the fibrous form of a soda-iron amphibole; the newly discovered Transvaal mineral to which the name of amosite has been given is a white magnesia-iron amphibole. It occurs as does crocidolite in cross-fiber, bedded veins in siliceous, hematitic sediments. The fibers reach the unusual length of 25 cm (ten inches) or more, and in its physical properties it closely simulates chrysotile asbestos. The amosite-bearing beds lie just above the great dolomite of the Transvaal system and within the influence of the Bushveld complex. It is believed by Hall that the solutions which transformed the silica and iron oxide of the sediment into asbestos emanated from the intrusive rock, possibly obtaining magnesia as they traversed the dolomite. It appears to be a remarkable case of complete and markedly selective metasomatic replacement on a large scale. The crocidolite veins of Griqualand are believed to owe their formation to a similar process, sodium-rich solutions emanating from an assumed underlying intrusive being the transforming agent. Nowhere, perhaps, so well as in these asbestos localities is an opportunity offered for the study of the mechanics of cross-fiber vein formation. Microscopic study of the replacement phenomena should also be rewarding.

THE BUSHVELD COMPLEX

Study in the field of the great laccolitic intrusion of the Bushveld in the northern Transvaal is the principal aim of the Shaler Memorial Expedition. Dr. Molengraaff first recognized the nature of this intrusive body twenty years ago. He now returns to renew its study, for notwithstanding the many workers who

have been interested in this region in the interval, there still remain many unsolved questions concerning it. These are chiefly of a petrographic or structural character. The processes of differentiation in this great intrusive body; the origin especially of the alkaline rocks; the structure of the mass as a whole; the sequence of lavas and intrusives and the structure of the Pilandsberg and its relation to the greater laccolite; the age of the laccolitic intrusion; these are some of the unsolved or but imperfectly solved problems from a petrographic viewpoint.

The mineralogist is attracted by the many types of alkaline rocks including pegmatites containing unusual minerals which have as yet been but imperfectly described; by the ore deposits of a number of metals which are satellitic to the laccolite; and by the various phases of contact metamorphism exhibited about its borders. The metals include particularly tin in characteristic cassiterite pegmatite and in quartz veins and pipes in the red granite; magmatic deposits of magnetite and chromite in the norite; and veins of copper, silver, cobalt and gold. The asbestos deposits have been already referred to.

I have attempted to present some of the problems that appear to the bibliographic student of South African mineralogy and petrology as possible subjects for profitable research. The field is large and varied and the writer will deem himself fortunate if he finds it possible to actually visit even a small part of the deposits here briefly pictured.

In conclusion let me add a word of appreciation of the energy and thoroughness displayed in the work of the South African geologists. They have described and elucidated with striking effectiveness the major elements of the earth features and mineral resources of their vast territory.

SECOND ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA

The second annual meeting of the Mineralogical Society of America was held at Amherst, Massachusetts, in conjunction with the thirty-fourth annual meeting of the Geological Society of America. Both the President and Vice President having previously announced their inability to be present, the Council designated Dr. Edgar T. Wherry as chairman of the meeting. The meetings were held in the Biological Lecture Room of Amherst College, the morning session being called to order at 9:30 A. M. Thursday, December 29th, 1921.

On motion of the Secretary the reading of the minutes of the last meeting, previously printed in the American Mineralogist (volume 6, No. 2, pp. 35-40) was dispensed with. The Secretary announced that 60 ballots had been cast for the Officers nominated by the Council, who are therefore elected for the year 1922:

President: Thomas L. Walker, University of Toronto.

Vice President: Frederick A. Canfield, Dover, New Jersey.

Secretary: Herbert P. Whitlock, American Museum of Nat. History.

Treasurer: Albert B. Peck, University of Michigan.

Editor: Walter F. Hunt, University of Michigan.

Councilor, 1922-1925: Thomas L. Watson, University of Virginia.

(On one ballot the name of Edgar T. Wherry was substituted for Editor.)

The report of the Secretary was then read. The report of the Treasurer was read in abstract by E. H. Kraus. An auditing committee consisting of A. S. Eakle and Ellis Thomson was appointed by the chair, and at the afternoon session reported the Treasurer's accounts correct.

The report of the Committee on Nomenclature and Classification of Minerals was read, and accepted as a report of progress. It was voted to send copies of this report to all fellows and members of the Society for criticism and comment during the coming year. The report of the Editor was then read, and the discussion of possible changes which might be made in THE AMERICAN MINERALOGIST in the next volume, was called for. In the course of this, several fellows emphasized the desirability of publishing book reviews and abstracts of all articles even tho lack of space should compel them to be greatly abbreviated. On a motion of Dr. Kraus a vote of appreciation was tendered to Dr. Wherry for his services as Editor. The reading by Dr. Wherry of the PRESIDENTIAL ADDRESS OF CHARLES PALACHE FOLLOWED; *Some Problems of Mineral Genesis in South Africa.* It is printed in full in this number.

It was announced by the Chair that the balance of the morning session would be given over to three crystallographic papers as follows: AUSTIN F. ROGERS, STANFORD UNIVERSITY. (1) *A study of crystal symmetry.* (This and the following abstracts have been made by the chairman.) The fundamental importance of the 32 symmetry classes was emphasized, and it was shown with the aid of lantern slides how these classes can be simply derived, in accordance with the mathematical theory of space groups, by performing certain symmetry operations upon the stereographic projection of a single (hkl) face. These operations comprise rotations of varying extent around symmetry-axes, reflection in symmetry planes, and shifting thru a symmetry center, the last, altho theoretically not necessary, being the simplest way of regarding the final operation. (2) *The use of plans and elevations in teaching crystallography.* By the use of a plan and one or more orthographic elevations it is possible for a student to determine graphically most of the features of a crystal,—the symmetry, the axial ratio, and the symbols of most if not all forms. This method has been recommended in a recent new edition of the speaker's "Introduction to the Study of Minerals," and is capable of even further applications, of which illustrations were given.

EDGAR T. WHERRY, U. S. BUREAU OF CHEMISTRY: *Crystallographic notes.* Cases where different methods of discovering hidden symmetry in crystals yield different results were pointed out, and the explanation suggested that physical methods

show the symmetry of the structure (point-system) while chemical methods may show symmetries latent in the constituent atoms.

The afternoon session was called to order at 2:15 o'clock, and it was announced that the remaining papers would be taken up as listed in the preliminary program, except that in cases where a speaker had more than one to present, his second one would be held over until other speakers present also had a chance.

OLIVER BOWLES, U. S. BUREAU OF MINES: *A plea for economic mineralogy.* (Read by E. H. Kraus.) It was urged that more attention be paid to the economic side of mineralogy in teaching the subject.

EDW. F. HOLDEN, UNIVERSITY OF MICHIGAN: *Caeruleofibrite, a new mineral.* A blue fibrous mineral in cavities in cuprite from Arizona, heretofore called fibrous azurite or connellite, proves on analysis to be an extremely basic chlor-arsenate of copper. In the discussion it was suggested that the name be simplified to ceruleofibrite.

EDGAR T. WHERRY AND EARL V. SHANNON, WASHINGTON, D. C.: *Crocidolite from Pennsylvania.* A deep blue coating on gneiss, diabase, and shale, is shown by analysis to be crocidolite. It is believed to be of contact-metamorphic origin, tho often far removed from the diabase which gave out the active solutions.

HENRY S. WASHINGTON, GEOPHYSICAL LABORATORY: *The jades of Middle America.* The results of analysis and petrographic examination of some prehistoric jade objects were announced. Jadeite, diopside, and albite in various proportions were the principal constituents.

A. L. PARSONS, UNIVERSITY OF TORONTO: *Analcite from Nova Scotia, with a discussion of the formulas of analcite analyses in general.* From new analyses on material of unusually good quality and critical study of older analyses, it was found that a certain amount of isomorphous mixture of high and low-silica end-members can be recognized.

ARTHUR S. EAKLE, UNIVERSITY OF CALIFORNIA: *An occurrence of monosulfide of iron.* A specimen of massive bronzy mineral found by a prospector in an inaccessible part of northern California proves on analysis to be the normal iron monosulfide, FeS. It has been formed by the alteration of magnetite, cores of which still remain. It differs from pyrrhotite in being non-magnetic and in its more ready solubility in dilute sulfuric acid. The relation between composition and physical properties in pyrrhotite needs further study.

N. L. BOWEN, GEOPHYSICAL LABORATORY: *Two corrections to mineral data.* The optical properties of the supposed new species "rivaite" being suspiciously near those of wollastonite, the speaker obtained a specimen of the original material from Prof. Zambonini, its describer, and found it to be a devitrified glass, the crystals being actually wollastonite, and the analysis having been made on this with glass adherent. Lacroix's "reaumeurite" was admittedly of the same nature, and hardly seems worthy a special name. The axial angle given in text-books for monticellite is only half what it should be, (an error in copying from Penfield's original paper being perpetuated by copying from one to another). This mineral has a rather large axial angle, and is represented in Larsen and Foshag's "mineral A" accompanying merwinite.

ALFRED C. HAWKINS, WARD'S NATURAL SCIENCE ESTABLISHMENT: *Crystallography of three Rhode Island minerals.* Crystals of hematite, epidote and apatite were described, the most remarkable being the hematite which showed dominance of a new steep rhombohedral form.

EDWARD F. KRAUS, UNIVERSITY OF MICHIGAN: *Mineralogy for students of Dentistry.* At the University of Michigan the dentistry students are now being taught mineralogy, from the point of view of recognition of the constituents of artificial teeth, enamels, cements, tooth pastes, etc.

EARL V. SHANNON AND EDGAR T. WHERRY, WASHINGTON, D. C.: *White chlorite from Pennsylvania.* Material similar in occurrence and properties to colerainite proves on analysis to agree with the chlorite sheridanite. New analytical and optical data on several minerals of this group are presented; their composition is complex, and for the present the only appropriate term for them seems to be "white chlorite."

A. L. PARSONS, UNIVERSITY OF TORONTO: *The care of Museum specimens.* The need of protecting silver minerals, realgar, etc., from light is emphasized. Methods of preventing loss of specimens thru oxidation, hydration, etc., should be developed.

ARTHUR S. EAKLE, UNIVERSITY OF CALIFORNIA: *The silicates of the contact-metamorphic limestone of Crestmore, California.* A summary of the unusual mineralogy of this deposit was given. From a study of the nature of the unusual silicates present, the course of the metamorphism is somewhat clarified.

JOSEPH J. RUNNER, UNIVERSITY OF IOWA: *Index minerals for the interpretation of geological history.* It was pointed out by the use of illustrations from Black Hills specimens how the metamorphic history may be epitomized in a single rock section, and a plea was made for the presentation of mineralogy to students from the genetic view-point.

ALBERT B. PECK, UNIVERSITY OF MICHIGAN: *A new type of monochromatic light source.* (Read by E. H. Kraus.) A strip of perforated platinum coated with platinum black can be impregnated with a salt of sodium, lithium, etc., and gives a brilliant and long-lasting source for monochromatic light. The apparatus was demonstrated at the close of the meeting

It is noteworthy that every paper offered for the meeting was actually presented, a record which we hope can be maintained in the future. The meeting adjourned about 5:30 P. M., a number of the mineralogists attending the G. S. A. dinner in the evening. The next annual meeting will be held at Ann Arbor, Michigan, on December 28, 1922.

The following fellows and members of the Mineralogical Society attended the meetings:

Ayres V. L., Case School of Applied Science.
Baker J. W., Pawtucket, Rhode Island.
Bowen N. L., Geophysical Laboratory.
Eakle A. S., University of California.
Gilson J. L., Waltham, Massachusetts.
Hawkins A. C., Ward's Natural Science Establishment.
Holden E. F., University of Michigan.
Honess A. P., State College, Pennsylvania.
Kraus E. H., University of Michigan.
Lane A. C., Tufts College.
Luquer L. McI., Columbia University.
Parsons A. L., University of Toronto.
Phillips A. H., Princeton University.
Ries H., Cornell University.

Rogers A. F., Stanford University.
Runner J. J., State University, Iowa.
Thomson E., University of Toronto.
Van Horn F. B., Case School of Applied Science.
Walker T. L., University of Toronto.
Washington H. S., Geophysical Laboratory.
Watson T. L., University of Virginia.
Wherry E. T., Bureau of Chemistry.
Whitlock H. P., American Museum of Nat. History.
Wolff J. E., Harvard University.

Report of the Secretary for 1921

The Secretary herewith reports that the rolls of the Society now comprise 66 Fellows and 155 Members, a gain of 18 Fellows and 30 Members for the year. The lists are printed in full on subsequent pages.

Respectfully submitted,
Herbert P. Whitlock, *Secretary*.

Report of the Treasurer

To the Council of the Mineralogical Society of America:

The Treasurer herewith submits his report covering the year from December 1, 1920 to November 30, 1921.

Receipts		*Expenditures*	
Cash on hand Dec. 1, 1920	$ 611.14	Ptg. Journal and Reprints	$1553.09
Dues and Subscriptions	1357.95	Stationery and other Ptg	32.85
Advertising	240.00	Postage	31.36
Sale, Back Numbers and Reprints	145.98	Purchase of Liberty Bonds from Life Payment of Dues	350.60
Goldschmidt Reprints	317.31	Miscellaneous	15.00
Miscellaneous	68.16		
	$2740.54		$1982.90
		Cash in Bank November 30, 1921	757.64
			$2740.54

A comparison of the mailing lists on November 30, 1921 and December 15, 1920 was as follows:

	Nov. 30, 1921	Dec. 15, 1920
Fellows	66	48
Members	155	125
Subscriptions	96	130
Unpaid for various reasons	5	17
	322	320

No accurate figure of the number of names dropped from the list for varying reasons can be given but when it is considered that the figures given above represent the present standing of the list, the net growth is hardly satisfactory.

The Treasurer takes this opportunity to offer his thanks to all who aided him in his work by paying dues and subscriptions unsolicited except by the published notice and trusts that the response to such will continue to be as good.

Respectfully submitted,

ALBERT B. PECK, *Treasurer.*

REPORT OF THE EDITOR FOR 1921

The 1921 volume, 6, of THE AMERICAN MINERALOGIST, Journal of the Mineralogical Society of America, contained 176 pages of text and 71 pages of covers, advertisements and indexes, a decrease of 37 and 14 respectively. This decrease was made necessary by increased costs of printing and by diminution in the amount of money available for the journal. The subject matter included may be classed as follows:

Subjects	*Articles*	*Pages*
Descriptions of new minerals, including discrediting of old ones, etc.	5	14½
New data, forms, occurrences, etc.	14	24½
Descriptions of famous mineral localities and collections	12	36½
Miscellaneous: addresses, obituary notices, tabulations, etc.	7	31
TOTAL ORIGINAL ARTICLES	37	
Proceedings of societies	28	30
Personal notes and news, book reviews, etc.	46	8½
Abstracted accounts of new minerals and discredited minerals	25	17½
Abstracts of crystallographic literature	29	3½
Abstracts of mineralogic literature	65	10
TOTAL ABSTRACTS AND NEWS ITEMS	193	
Illustrations	16	
TOTAL PAGES		176

Two new mineral species were described in this volume for the first time, jurupaite and merwinite, while new data was furnished on flagstaffite, and two supposed species, "allemontite" and "colbranite," were discredited.

The editor has endeavored to include in every number both technical and nontechnical articles; and there has been no difficulty in obtaining sufficient manuscript for this purpose. The limitation in the number of pages in the volume made necessary by our slender resources has led, indeed, to delay in publication of the longer articles for periods of 6 months to a year after their receipt. It has also seemed wise to diminish the space allotted to abstracts, which has resulted in our running about two years behind in this respect. In order to catch up, it will probably be desirable to limit our abstracts to 2 or 3 lines each during the coming volume. However, with increasing membership and decreasing costs of printing, it is to be hoped that gradual increase in size of the journal will be possible in future volumes.

Respectfully submitted,

EDGAR T. WHERRY, *Editor.*

FELLOWS OF THE MINERALOGICAL SOCIETY OF AMERICA

(*Indicates charter fellow.)

*Dr. Elliot Quincy Adams, Research Dept., Nela Park, Cleveland, Ohio.
*Frederick Noel Ashcroft, M.A., 37 Palace Court, Bayswater, London W 2. [Life fellow.]
*Miss F. Bascom, Bryn Mawr College, Bryn Mawr, Pa.
*Prof. William S. Bayley, University of Illinois, Urbana, Ill.
*Dr. N. L. Bowen, Geophysical Laboratory, Carnegie Institution, Washington, D. C.
*Oliver Bowles, Bureau of Mines, Washington, D. C.
*Dr. E. L. Bruce, Queen's University, Kingston, Ontario.
*Dr. Henry L. Buttgenbach, 439 Avenue Louise, Brussels, Belgium.
*Frederick A. Canfield, Dover, N. J.
*Robert W. Clark, Petroleum Bldg., Okmulgee, Oklahoma.
*Prof. Charles Wilford Cook, Ann Arbor, Michigan.
*Prof. R. D. Crawford, 1050 Tenth Street, Boulder, Colorado.
*Dr. A. R. Crook, State Museum, Springfield, Ill.
*Prof. E. S. Dana, Yale University, New Haven, Connecticut.
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PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, January 12, 1922

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Mr. Trudell, in the chair. Fifteen members were present.

Mr. Hilbiber described collecting experiences at Perkiomenville and Wilmington. Mr. Hoadley exhibited a slab of pink crystals measuring 1 cm. in length, from Franklin, N. J., alleged to be leucophoenicite. Optical examination showed the mineral to be rhodonite. Dr. Wills exhibited some sections of local minerals and rocks.

The following were elected to active membership: Mr. Frank J. Keeley, Mr. Arthur Low, and Mr. Walter Lapp.

SAMUEL G. GORDON, *Secretary.*

NEW YORK MINERALOGICAL CLUB

Regular Monthly Meeting of February 15, 1922

The regular monthly meeting of the New York Mineralogical Club was held in the American Museum of Natural History on the evening of February 15 at 8:00 P.M.

The President, Dr. George F. Kunz, presided and there was an attendance of 22 members. The minutes of the last meeting were read and approved. The Committee on Membership reported favorably on Mr. Rodney B. Miller, 149 Columbus Ave., Newark, who was declared elected to membership, the Secretary being instructed to cast a single vote for his election. The name of Mr. Edwin F. Gross of 1169 East 17th Street, Brooklyn, was referred to the Committee on Membership on the nomination of Mr. Grenzig.

Mr. Hoadley spoke of the lecture of Dr. Samuel G. Gordon before the Philadelphia Mineralogical Society and moved that Dr. Gordon be invited to give his lecture before the Club at the March or April meeting. The matter was referred to a Committee, consisting of Messrs. Hoadley, Stanton and Whitlock, with power.

The President introduced the speaker of the evening, Dr. Esper S. Larsen of the U. S. Geological Survey, who gave a highly interesting and valuable address on "The Microscopic Determination of Non-Opaque Minerals." Dr. Larsen spoke of the importance of the optical properties of minerals from a determinative standpoint emphasizing the special importance of index of refraction as a determinative factor. He stated that the fundamental optical characters of minerals are few in number and susceptible to tabulation which makes possible the accurate determination of an unknown mineral by this method. The added advantage of the method is that it can be applied to very small amounts of material. The speaker described the petrographic microscope and pointed out its function as a determinative instrument for this method. He showed how indices of refraction could be determined by comparing grains of the unknown mineral with embedding fluids of known index

and demonstrated the determination of pleochroism and index of refraction, using the projecting apparatus and a Leitz model petrographic microscope.

At the conclusion of his address a vote of thanks was tendered to Dr. Larsen for his highly valuable address. The meeting adjourned at 10 P. M.

HERBERT P. WHITLOCK, *Recording Secre'ary.*

BOOK REVIEW

A MANUAL OF DETERMINATIVE MINERALOGY, WITH TABLES FOR THE DETERMINATION OF MINERALS BY MEANS OF: I. THEIR PHYSICAL CHARACTERS; II. BLOWPIPE AND CHEMICAL PROPERTIES. J. VOLNEY LEWIS. 298 pages. John Wiley & Sons, Inc., New York, 1921.

While this is the third edition of a book by the same leading title, it is essentially a new work, for the former blowpipe tables have been, as stated in the preface, thoroly revised and recast, and new tables for identification by physical properties alone have been added. By way of introduction a list of the physical properties of minerals is given; it covers, however, only eleven pages, and could have been considerably enlarged to advantage. The data are up to date except that the imperfections which we now know to exist in the Mohs hardness scale (in which the numbers 4 and 5 are identical in hardness, and 8 not far different from 7), are not warned against.

The physical tables, which fill more pages than the blowpipe ones, and cover nearly 300 minerals, are unusually skilfully worked out. Luster, which is well known to be a stumbling block to students in many tables, is eliminated as the basis for the first subdivision, and streak which is decidedly easier for a beginner to ascertain definitely, is substituted. No use appears to be made, however, of the "rubbed streak"—i. e., the result of rubbing the ordinary streak with a bit of clean streak plate—altho it is very helpful in distinguishing such closely similar minerals as stibnite and bismuthinite, manganite and pyrolusite, etc. The second subdivision is based on color, and the third, where necessary, on cleavage. In the smallest divisions the minerals are arranged in the order of increasing hardness. Under each mineral, synonyms, composition, properties and occurrences are listed. No attempt is made to feature special properties as especially characteristic, altho this might be helpful in confirming certain minerals. For example, when the table brings together chondrodite and cassiterite, the mere lifting of the specimen would be enough to tell which was which; when fluorite and chabazite, gentle heating in a dark corner would distinguish them; vivianite and gypsum, the rubbing for a short time in a mortar would lead the former to turn blue. The least that might be done would be to in some way emphasize a few of the most characteristic of the properties listed, so as to make wading thru the whole list unnecessary. On the whole, however, the physical tables are well arranged, and should prove very useful in practical identification.

The part of the book devoted to the blowpipe methods is an improvement over the previous editions, excellent tho these were. The introductory descriptions of methods and tests are elaborate; and their completeness is evidenced by the fact that not only is the flame color of manganese chloride—omitted from most min-

eralogies—included, but even its modifications as seen thru the different strips of the Merwin screen. The actual tables, including some 350 minerals, are arranged in tabular fashion after the plan made familiar in this country by Brush and Penfield. It seems a little inconsistent to use luster for the first subdivision here when it was definitely excluded in the other set of tables, altho of course the need of avoiding the heating of metallic minerals in contact with platinum makes this here less easy to change. Perhaps the freer use of modern alloys like nichrome for blowpipe apparatus—which by the way does not appear to be mentioned—will ultimately make even this time honored basis of subdivision disappear from blowpipe tables. Abbreviations are rather freely used, but many of them seem rather awkward, as Cp. for compare (which is too much like a chemist's abbreviation for comparatively poor; cols. for colorless; gryh. for grayish and other colors corresponding; per. for perfect; somet, for sometimes; st. for streak (str. would be better); and us. for usually. Judging from the rather large amount of blank space in the various columns, the writing out of many of the abbreviated words would not increase the volume materially. After all, however, the purpose of an identification table is to identify, and it would be difficult to improve upon these tables for that end. Some useful lists of minerals arranged according to crystallization and hardness are also given; it seems a pity that all known minerals could not have been included.

Lewis' Determinative Mineralogy is well printed, with extraordinarily few compositor's errors, and no obvious scientific ones. It should be valuable alike as a college text-book and for use by anyone desiring to become familiar with or to identify the more important minerals. W.